

following remark (Bulletin of Museum of Comparative Zoology, Cambridge, Mass., 1881, vol. ix. p. 78): "It seems to have been overlooked until now, that we are indebted to Sowerby for its characterization, and that he is entitled to be cited as authority for the genus." But on referring to James de Carle Sowerby's description of the genus *Pleurotomaria*,<sup>1</sup> Min. Conch. vol. vii. p. 69, pl. 640 (published November, 1844), he cites DeFrance as his authority.

It is true that in DeFrance's "Tableau des Corps Organisés Fossiles" (8vo. Paris, 1824), he merely gives the name (p. 114); but in the "Dictionnaire des Sciences Naturelles" (vol. xli. 1826, p. 381), De Blainville adopts DeFrance's name, and credits him with most of the new species described. It is also perfectly true that Sowerby defined the genus, but to assume that he founded it would be unjust to DeFrance, especially since both De Blainville and Sowerby have given DeFrance credit for the genus. If such a rule, as is thus proposed by Mr. W. H. Dall, were generally adopted by naturalists, endless confusion would arise and great injustice would be done to all the older naturalists whose work laid the foundation for the researches of the generation of younger men who have followed after.

#### EXPLANATION OF PLATE XI.

FIG. 1a. *Pleurotomaria Beyrichii*, Hilgendorf. Recent. Enoshima, Japan. (Nat. size.)

„ 1b. Portion of the slit-band (enlarged).

„ 2 *Pleurotomaria reticulata*, Sby. (nat. size). Kimmeridge Clay, Wotton-Basset.

The nacreous inner layer of the shell is well preserved.

Fig. 1 is from the cabinet of Mr. R. Damon, F.G.S., of Weymouth.

Fig. 2 is preserved in the British Museum (Natural History).

Note.—Mr. Robert Damon has kindly given me permission to retain his specimen of *Pleurotomaria Beyrichii* on exhibition for two months in the table-case with the fossil *Pleurotomariæ* in Gallery B, Department of Geology.—H.W.

## II.—ON BASTITE-SERPENTINE AND TROKTOLITE IN ABERDEENSHIRE, WITH A NOTE ON THE ROCK OF THE BLACK DOG.

By Prof. T. G. BONNEY, D.Sc., LL.D., F.R.S., Pres.G.S.

IN a paper entitled "On Minerals new to Britain,"<sup>2</sup> published in the Mineralogical Magazine, vol. v. p. 1, Professor Heddle mentions the occurrence of a bastite-serpentine at two localities in Aberdeenshire; one in the parish of Belhelvie, the other on the shore close to a curious rock named the Black Dog. A visit to the localities has enabled me to add to his account some particulars, and to offer one or two corrections which seem to me not unimportant.

Professor Heddle states that he found the rock in the former case "in two quarries which are cut into a hill-side near the farms of Craige and White-Cairns, on the west side of the Belhelvie hills."

<sup>1</sup> Sowerby's description is as follows:—"PLEUROTOMARIA, DeFrance. Gen. char. A trochiform spiral shell, with an angular sinus near the middle of the outer lip, from which a band marked with lines of growth that indicate the sinus is carried round the whorls; no beak or sinus at the base of the aperture; a columella with or without an umbilicus."—(Sowerby, Min. Conch.)

<sup>2</sup> In this paper the term mineral is used in a very wide sense, as it includes *tachylite*, *Lydian-stone*, *chert*, *lignite*, *spherulite*, and *pitchstone*. If all of these are minerals, what are left to us as rocks?

I believe that I visited the same locality, though I could only find one quarry in serpentine (very probably two excavations have now been worked into one). The locality is about eight miles from the town of Aberdeen, and a short distance to the east of the high road to Tarves.<sup>1</sup> The quarry is close to a branch road and is visible from the main one. I was told that the name of a farmhouse, which stands on the ridge, a short distance north of the quarry, is Overhill. This ridge is a conspicuous feature, running for a considerable distance roughly parallel to the road, as the above-mentioned quarry is approached. It is no doubt a portion of the "ridge of dark trap," which is mentioned in the Ordnance Gazetteer of Scotland as "starting from the Black Dog's mouth, and running through the entire parish of Belhelvie, from four to six furlongs wide, . . . flanked at one point by serpentine."

The outcrop of serpentine is but a small one, for it does not appear to extend much beyond the limits of the pit. The ridge here, and doubtless elsewhere, mainly consists of a rock of rather variable coarseness, which much resembles the well-known troktolite (or forellenstein), of Volpersdorf. This similarity struck me at once in the field, and is fully borne out by microscopic examination. My remarks will be chiefly directed to the structure of these two rocks and their relations.

The matrix of the serpentine is compact, of a dark brownish to greenish black colour, speckled by very minute crystals or granules of a mineral resembling one of the spinellid group. There are irregular patches, two inches or more in greatest diameter, of a greenish-white, steatite-like mineral full of small rounded inclusions of the dark matrix; so as to form a kind of rude network or cell-like structure. Closely associated with this are crystalline grains of bastite (with the usual rounded inclusions of the matrix), at most about one half of an inch in diameter, and of rather feeble lustre. From the general appearance and relation of these two minerals, one would conclude that the white mineral was the result of a further change of that represented by the bastite. The rock in its general aspect, jointing, fracture, and mode of weathering, corresponds with a true serpentine, such as that of the Lizard. It very closely resembles my hand-specimens of bastite-serpentine from Baste (Hartz), Kupferberg (Bavaria), and Sta. Catarina (Elba). Of the first and third I possess slides, which prove the rocks to be almost identical.

The Belhelvie serpentine (rock) consists of the following minerals: (1) *Olivine*, more or less converted into varieties of the mineral serpentine, with separation of the iron in the form of magnetite, etc. I have so often described the gradual formation of the "strings" of greenish and rather fibrous serpentine along the cracks of the original olivine, and the way in which they, and sometimes the mineral occupying the interstices between them, are discoloured by the deposit of magnetite, hæmatite, etc., that it is needless to occupy any space by repeating the usual details. Portions

<sup>1</sup> It is marked on Dr. A. Geikie's Geol. Map of Scotland.

of unaltered olivine still remain in fair number between the serpentinous strings, which in several cases are shown to be remnants of one crystal, by identity of colour when placed between crossing Nicols. (2) *Bastite*, etc., viz. enstatite in various stages of alteration. This mineral, as is common, includes some olivine grains like an irregular setting, and therefore must belong to a later epoch of consolidation. We find it in various stages, from a characteristic enstatite, not very much altered, to a kind of steatite speckled with earthy-looking granules, and so rendered occasionally almost opaque. Sometimes the steatitic product is isotropic, at others it appears as an aggregate of very minute moderately bright-coloured granules. (3) Besides these, the slide exhibits a fair number of grains, not very regular in outline, either opaque or very dark brown in colour, most likely representatives of the spinellid group, and in part probably chromite.<sup>1</sup>

Thus the serpentine has been derived from an olivine-enstatite rock, such as would be called a *Saxonite* by Dr. Wadsworth.

The serpentine has been worked back to its junction with the troktolite, which constitutes the main mass of the ridge. This is usually a moderately coarse-grained mixture of purplish-grey or whitish felspar and dull dark-green serpentine. Coarser varieties occasionally occur; usually the felspar is to the serpentine in about the proportion of three to two, but occasionally a fragment is seen in which the former mineral distinctly predominates. A pyroxenic constituent, if present, is very inconspicuous. The rock is boldly but rather irregularly jointed and weathers with a brown rough surface.

I have examined a series of slides representing the average rock of this part of the ridge, the coarser kind, and varieties respectively rich in felspar and in serpentine. In the normal rock the felspar is fairly well preserved, though rather cracked, probably by molecular strains due to the alteration of the olivine constituent. It exhibits the usual twinning of plagioclase, the groups of macles being combined in both the Carlsbad and perikline types, and the large extinction angles show that anorthite is present. The olivine has been almost wholly converted into an olive-green to greenish-brown serpentine with the usual structure; only rarely does a fragment of the original mineral remain unaltered. There is a certain amount of diallage, more than one would have expected from a macroscopic examination of the rock. This occurs in rather small irregular "interstitial" looking grains, and now and then includes or is pierced by a small crystal of the felspar, having been the last to consolidate. There are also a few grains of iron oxide. One slide is traversed by a vein of chrysotile. In the coarser varieties the felspar is not quite as well preserved, but a fair amount of olivine is still unaltered, the two minerals being more nearly in equal proportions. In this there is little or none of a pyroxenic constituent.

<sup>1</sup> Plate viii. figs. 2 and 3 (one of the peridotite of the Hartz, the other of that from Christiania) in Dr. Wadsworth's *Lithological Studies*, part i. would very fairly illustrate the serpentine described in this paper.

I possess a slide of the Volpersdorf troktolite, and have to thank Prof. Judd for the loan of others, as well as of a slide of the same rock from Baste. All these agree very closely with the rock described above. In them also, diallage is sparingly present in narrow irregular-shaped grains, so as not readily to catch the eye in hand-specimens (one, however, of my specimens of Volpersdorf rock has two or three conspicuous crystals of diallage). Hence we need not hesitate to call the Belhelvie rock a troktolite or forellenstein.

In my paper on the Serpentine of the Lizard (*Quart. Journ. Geol. Soc.* vol. xxxiii. p. 906), I describe a rock from Coverack Cove, as being almost identical with the forellenstein of Volpersdorf, and this was afterwards confirmed by an analysis by Mr. F. T. Houghton (*GEOL. MAG.* Dec. II. Vol. VI. p. 504).<sup>1</sup> The Coverack troktolite, however, has probably a little more diallage than the Volpersdorf rock, and in the specimen analyzed there was only 33 per cent. of olivine as against 45 per cent. in the latter rock. Macroscopically and microscopically, this Belhelvie troktolite looks even nearer the Volpersdorf type than that of Coverack Cove. A chemical analysis, however, for which I am indebted to the kindness of A. E. Brown, Esq., B.Sc., of University College, London, shows that on the whole the Belhelvie rock is more closely allied to the troktolite of Coverack than to that of Volpersdorf, and the per-centage of  $\text{Al}_2\text{O}_3$  is rather larger, and that of  $\text{MgO}$  rather smaller, than my estimate founded on microscopic examination led me to expect. The following is the analysis ( $\text{S.G.} = 2.73$ ).

$\text{H}_2\text{O}$	...	...	...	...	...	...	...	8.12
$\text{SiO}_2$	...	...	...	...	...	...	...	39.87
$\text{Al}_2\text{O}_3$	...	...	...	...	...	...	...	24.30
$\text{Fe}_2\text{O}_3$	...	...	...	...	...	...	...	1.59
$\text{FeO}$	...	...	...	...	...	...	...	4.09
$\text{CaO}$	...	...	...	...	...	...	...	7.61
$\text{MgO}$	...	...	...	...	...	...	...	11.30
* $\text{K}_2\text{O}$	...	...	...	...	...	...	...	1.11
* $\text{Na}_2\text{O}$	...	...	...	...	...	...	...	1.93

99.92

<sup>1</sup> I append the analyses made or quoted by Mr. Houghton. I. is the Volpersdorf rock, II. that of Coverack, III. the felspar of No. I., IV. the felspar of No. II. From the latter two it is evident the Coverack rock contains rather more labradorite than the Volpersdorf rock. I think, however, that the specimen analysed of the latter rock must have been a little richer than common in olivine.

	I.	II.	III.	IV.
$\text{H}_2\text{O}$	8.30	4.38	1.87	3.19
$\text{SiO}_2$	41.13	45.73	47.05	49.65
$\text{Al}_2\text{O}_3$	13.56	22.10	30.44	29.34
$\text{Fe}_2\text{O}_3$	2.19	0.71	1.56	0.59
$\text{FeO}$	6.19	3.51		
$\text{CaO}$	6.72	9.26	16.53	12.18
$\text{MgO}$	22.52	11.46	0.09	0.46
$\text{K}_2\text{O}$	0.83	0.34	0.78	0.48
$\text{Na}_2\text{O}$	0.96	2.54	2.10	3.61
	102.40	100.03	100.42	99.51

\* Mr. Brown adds, "The values of these are uncertain—the numbers given are the means of two experiments: the limits between which the value may lie are  $\text{Na}_2\text{O}$  1.85 to 2.33,  $\text{K}_2\text{O}$  1.19 to .71.—Total 3.04."

I may call attention to another point of resemblance between the Cornish and Belhelvie rocks in their relation to the serpentine. At Coverack Cove the serpentine is the oldest rock; it is cut by the troktolite, and both are cut by an ordinary coarse olivine-gabbro. Now the serpentine and troktolite are so closely united that at the first glance we might suppose the one passed into the other. This, however, is certainly not the case, but the junction is so perfect that they appear, as it were, fused together; while at the junction of the olivine-gabbro and the serpentine there is commonly a line of division or a crack, which is enlarged by weathering. It would be interesting to see whether in the Belhelvie ridge there were any indications of a normal gabbro and what was its relation to the other rocks. Professor Judd has also observed the complete sequence of serpentine (or peridotite), troktolite, and olivine-gabbro in the western isles of Scotland. For the last rock to cut serpentine is common.

One point remains for consideration. What is the relation of the troktolite to the bastite-serpentine? Do they form part of one and the same eruption, or is the one distinctly subsequent to the other? The difference between the two rocks, notwithstanding the rapid variation which is often exhibited by peridotite rocks, seems too great to render the former hypothesis very probable; further, by careful search I discovered in one part of the pit a fairly sharp junction between the serpentine with bastite and the troktolite, of which I succeeded in securing specimens. I noticed, however, that in one place the troktolite, probably at a distance of three or four feet from this apparent line of demarcation, changed in the course of about three inches from a variety in which the felspar distinctly prevailed over the olivine to one in which there was more olivine than felspar, perhaps twice as much. In the latter the felspar is almost wholly replaced by secondary products. The greater part of the replacing substance is a minutely granular to slightly fibrous material, which with crossed Nicols changes, as the slide is rotated, from dark to a pale milky or greyish white; in it are scattered a few granules giving rather bright colours. Much of this might readily be taken for a steatitic mineral, but on testing the spots at the surface of the rock with a knife the hardness appears to be nearly that of felspar. I have examined a slice cut to exhibit the above-mentioned junction. It is rather less than an inch long; about  $\frac{2}{3}$  in. being troktolite, the remainder serpentine. The former (except for the presence of a peculiar structure to be noted presently) is a normal troktolite, with the plagioclase felspar quite distinct, though much cracked; the latter, consisting mainly of altered olivine, exhibits among this mineral two or three irregular interspaces occupied by a clear substance, which with transmitted light does not differ much from the felspathic portion of the troktolite, but which with crossed Nicols remains wholly, or almost wholly, dark in every position, and is probably steatite. This can be scratched easily with the knife-point, while the colourless mineral of the troktolite is not easily so marked. At the same time the slide does not exhibit the sharp demarcation commonly seen when one igneous rock has

intruded into another, but the boundary is irregular, the felspathic portion of the troktolite seeming to pierce or send off-shoots into the serpentine. This debateable region may be about one-eighth of an inch wide. As in addition each rock in the slide is about of its normal coarseness, I should conjecture that the intrusion took place when the older rock was at a high temperature, and perhaps was still plastic. Which, then, was the earlier? At Coverack, in the instances on the West Coast of Scotland described by Prof. Judd, and in several cases where I have examined the junctions of ordinary gabbros and peridotitic serpentines, the felspathic rock is the later of the two; though I may add that its coarse crystallization seems to indicate that its cooling was very gradual. In this case it is more difficult to come to a conclusion. The felspar of the troktolite near to the junction appears to occur in slightly smaller grains than in the normal rock, but the difference is slight and the rock variable. There is, however, one peculiarity. Near to the junction every grain of olivine is surrounded by a fringe-like border, resembling an incipient spherulitic structure. In some cases this appears double, the zone nearest the olivine consisting possibly of a serpentinous mineral; but the outer, and in some cases the only mineral occurring, is a long and somewhat fibrous microlith, which from its general aspect and extinction-angle I should judge to be actinolite or tremolite.<sup>1</sup> In these slides the flakes or border of diallage noticed in the normal rock are wanting. It is possible that the structure might be a result of the intrusion of the serpentine into the troktolite; but on the whole I incline to the opinion—though not without hesitation—that the former rock is the earlier.

The Black Dog is a mass of rock about four yards long and broad, and rather more than two high, which projects from the sand and bears a very rude resemblance to the creature from which it is named. A dozen or more of much smaller blocks are scattered about in the neighbourhood, some a little nearer to, some a little further from the land. Most, if not all, of these can be visited at low water. Rain and wind prevented me from attempting to plot down these blocks (whether they are *in situ* or boulders I cannot say), and obliged me to content myself with a rather hasty examination of them. Professor Heddle speaks of two masses of serpentine, a little seaward of the Black Dog. I obtained my specimens from two masses rather on the landward side (and to north of it), and there was a third not far from these, but I noticed two or three more dark blocks surrounded by the sea, which may have been those spoken of by Professor Heddle. Of the remaining blocks, one was certainly a dark gneiss; the others appeared to me to resemble the rock of the Black Dog, but at these I barely glanced.<sup>2</sup> Macro-

<sup>1</sup> These or other microliths sometimes pierce the felspathic part of the slide in a way that recalls the canal system of Eozoon, but to discuss this would require too long a digression for the present occasion.

<sup>2</sup> Boulders are not common on this part of the shore. In fact, I do not remember observing one for about a mile and a half to the south, so that the rock probably is either *in situ* or has come from the immediate neighbourhood.

scopically the only difference between this serpentine and that of Belhelvie is that in the former there are much larger masses of the bastite and much less of its steatitic alteration products. Under the microscope the differences are but varietal.—rather less olivine remains unchanged, and the slides have a rather greener hue; this colour here and there occurring rather markedly in little filmy patches, as if a small amount of a chloritic mineral were present.

Professor Heddle gives an analysis of this bastite, freed as far as possible “from the dark serpentinous rods which penetrate the mineral in so singular a manner” (these of course are the included grains of serpentinized olivine).

By the side of it (I.) I place for comparison an analysis (II.) of the bastite from Baste<sup>1</sup> (Köhler, quoted by Dana, Mineralogy, p. 469):

	I.	II.
SiO <sub>2</sub> ... ..	38·186	43·90
Al <sub>2</sub> O <sub>3</sub> ... ..	2·178	1·50
Cr <sub>2</sub> O <sub>3</sub> ... ..	·276	2·37
Fe <sub>2</sub> O <sub>3</sub> ... ..	·028	...
FeO ... ..	8·479	10·78
MnO ... ..	·513	·55
CaO ... ..	2·912	2·70
MgO ... ..	31·418	26·00
K <sub>2</sub> O ... ..	1·401	·47
Na <sub>2</sub> O ... ..	·065	...
H <sub>2</sub> O ... ..	14·030	12·42
	100·486	100·69

Enstatite, more or less altered, is common in British serpentines, but this is the first instance I have seen of the varietal form bastite,—if we restrict this name to the large grains with inclusions of more or less altered olivine.

I pass on now to the rock of the Black Dog. This, according to Professor Heddle, “consists of crystals of *talc*, matted in such confusion as to form both a tough and a hard rock.” As talc is about the lowest mineral in the scale of hardness, and its allies steatite, agalmatolite, etc., are all rather soft; and as minerals do not generally change their physical characteristics, however confusedly they may be matted, I looked forward to the examination of the Black Dog with much interest. Wet as it was with waves and rain, I could only see that it was a mottled dull-green to black rock, sparsely speckled with small scales of a silvery mica, and not unlike the troktolite; when dry, however, it appeared slightly foliated in structure. Smoothed by the action of the waves it presented but few prominences. Selecting one of the least unhelpful I endeavoured to detach a specimen. A very few minutes sufficed to show the impossibility of any form of talc being the dominant mineral. I plied vigorously a fairly heavy hammer for about five minutes, first at one place, then at another hard by it, with only this result:—that I detached one chip about as large and as thick as a florin and a number of tiny splinters. The latter had set their

<sup>1</sup> Comparison of these renders it highly probable that II. was more completely freed from the olivine grains than I.



mark effectually on my right hand in the form of three cuts, one pretty deep. At last, after one or two more unsuccessful attempts, I secured a moderate-sized fragment of a rock which I may fairly describe as one of the hardest and toughest that I have ever assailed. It needed but a glance to show that the rock was highly crystalline, and quartzose, without any mineral that could possibly be compared with talc, except the not very abundant silvery mica. I believe there is only one Black Dog, or I should have supposed, so obviously incorrect is Prof. Heddle's statement, that he were speaking of some other rock.

The rock on a smoothed surface has a dull grey or bluish-grey colour, mottled or rather streaked in an irregular fibrous manner with a darker, almost green-black tint, and spangled with a few small flakes of a silvery mica. A broken surface exhibits a more or less crystalline structure, with an irregular fracture, as if the component minerals were tough and had been torn asunder rather than snapped. On these surfaces the grey assumes a rather more distinctly violet-blue tint. The outer part and the surfaces of fissures are stained brown. The slides, viewed with reflected light, in certain positions also exhibit in parts a slightly bluish hue. This is very faint, but I think indubitable, and much resembles the peculiar violet-blue of some varieties of cordierite (iolite).

On examining the slide with a one-inch objective, by transmitted light, we see a number of wavy, more or less translucent subparallel streaks, varying in colour from dull light-brown to dusky grey, which have a fibrous aspect and evidently consist of fine aggregated hair-like minerals which stick out in the streaks in various directions, though on the whole they maintain the same general orientation. We may in fact compare the streaks to rather matted locks of hair. Between these is a mineral generally clear, but sometimes a little dirty-looking, which occasionally exhibits a granular structure; among both these a number of black grains, sometimes more or less rounded, sometimes angular, are scattered rather irregularly. Here and there we observe a mineral resembling a white mica in detached crystals, with irregular patches of a rather gummy-looking yellowish-brown mineral, and some small crystals of a brown mica.

After a careful examination of the hair-like mineral with high powers, I have come to the conclusion that in all probability the greyer and the browner patches are alike aggregates of the acicular microliths which project from the edge, but possibly the latter may be darkened in colour by the inclusion of some exceedingly minute ferrite (though even with a one-eighth objective I can make out nothing definite beyond the crowded microliths); and that we may safely regard this mineral, so abundant in the slide, as a variety of fibrolite. It is almost exactly like that in the cordierite-gneiss of Bodenmais, which, however, sometimes has the microliths of larger size, resembling those in a typical specimen of fibrolite from the same locality, which I have in my collection.

Among the colourless minerals I notice that a fair proportion have one well-defined cleavage, while of the remainder, some present



only faint indications of it, or indicate no more than a tendency in a parallelism of included microliths, while others show no sign at all. Among the first, some are certainly the white mica, the larger grains of which are visible to the unaided eye. These give bright colours with crossed Nicols, extinguish parallel with the cleavage planes, and have a rather spangled or satiny aspect, even at the moment of extinction. In a word this mineral reminds me in its general aspect of a hydrous mica, and is not unlike paragonite. But there is another well-cleaved mineral, which, though showing bright colours and well cleaved, gives more uniform tints, and I think more frequently contains inclosures of fibrolite than the mica. I suspect this to be kyanite. Of the remaining clear grains, including some without visible cleavage, the extinction, where cleavage planes are visible, is parallel with them. The colours, though they have a general resemblance to those of quartz, are rather more intense than is usual with it. The mineral also is not quite so clear and glass-like, and not seldom gives indications of incipient decomposition. This I consider to be very probably iolite. Other grains, however, are certainly quartz. The black granules are an iron oxide, and are probably in great part hæmatite. As pyrrhotite is present at Bodenmais, I have looked carefully for this mineral, but cannot detect it. The yellow-brown mineral occurs in irregular filmy patches and exhibits no definite structure. With crossed Nicols, it either remains dark, or gives very faint indications of an aggregate structure. Some, I feel sure, is a staining of hæmatite or limonite. This also occurs in some of the Bodenmais rock. The brown mica calls for no special remark.

A few other microlithic minerals are present which I am not able to identify with precision. In one slide, however, I find a single instance of a peculiar mineral. It is a patch of irregular outline, (including several of the black grains, with little if any fibrolite), in diameter about .07 inch, with one or two small outliers—cleavage very dubious, possibly indications of two meeting at angles not very far from 90°—pale puce-grey or dove-coloured by ordinary transmitted light—strongly dichroic—extinction seemingly parallel with the best indicated cleavage, which corresponds with a slightly fibrous appearance,—dull olive-green for vibrations perpendicular to this; light dove-coloured or puce-brown for parallel vibrations. The general look is like that of a mica in which the usual basal cleavage is not distinctly shown, as is the case with some of the brown mica in the slide.

As the fibrolite appears to be present not only in the altered iolite, but in the quartz and in these streaky masses, it is probably of independent origin.

We may then, I think, confidently affirm that this Black Dog rock principally consists of fibrolite (sillimanite), iolite more or less altered, quartz, and some micas.

The above described slides present considerable resemblances to some from the cordierite-gneiss of Bavaria. Some of the latter contain very conspicuous cordierite, but others almost exactly re-

semble the Black Dog rock, and these abound in the minute, thickly aggregated fibrolite. There is a generally similar association of minerals in the cordierite-gneiss of Galgenberg. I am greatly indebted to Professor Judd for the loan of additional slides of the Black Dog rock, made from my specimens, and for a series of slides of cordierite rock from the above-named localities, and from Burgstadt (near Chemnitz), Penig, Orijesvi (Finland), and Sertudalen (Sweden).

About half-way between the Black Dog rock and the mouth of the Don,—and so about half a league N. of the latter, sundry blocks of a dark rock are strewn on the shore, some of considerable size. One is apparently a dark gneiss, others are evidently an igneous rock. I collected two varieties, one representing the two largest blocks which lie close together, as though they had once formed a single mass. It is a heavy dark green rock speckled with grains of a lighter colour, weathering brown. The following is a description:—holocrystalline, structure intermediate between granitoid and ophitic, consists mainly of labradorite, augite and some olivine. The labradorite is well preserved, exhibiting the usual lamellar twinning and very bright colours with the crossed Nichols; the augite, or rather diallage, for the pinacoidal cleavage is generally well developed at the expense of the prismatic, is light brown-coloured in many of the grains, and exhibits the “schillerization” to which Prof. Judd has lately drawn attention; the olivine (not abundant) has its cracks bordered with a staining of opacite; some parts are converted into a dull brownish-green serpentine, but others are very well preserved. A few larger granules of black iron oxide occur in the slide. Another specimen of a finer-grained rock contains no olivine, but a little brown mica; the pyroxenic mineral also is partly diallage, partly a mineral of the hypersthene group, probably allied to the variety called amblystegite; it is distinguished by a more marked dichroism, altering from a pale greenish to a bluish hue, and extinguishes parallel with the pinacoidal cleavage. The mode of occurrence of the two minerals, which are not always easy to distinguish, is very similar, and they appear to have consolidated as nearly as possible simultaneously. There is also some apatite in the slide, and as usual some grains of iron oxide.

### III.—ON THE ORGANIZATION AND ECONOMY OF THE GRAPTOLITHIDÆ.

By Dr. OTTO HERRMANN.<sup>1</sup>

IN the first place, let us obtain a clear idea of a Graptolite, and for this purpose we will consider two members of the family Dichograptidæ, namely, *Didymograptus vacillans*, Tullb. (Fig. 2, p. 452), and *Dichograptus octobrachiatus*, Hall (Fig. 1, p. 449).

The entire polypidom (Hydrosoma, polypary, Frond, “polypier,” “polypariet”) proceeds from a simple, hollow cone (sicula, “Füss,” “Haftorgan,” Radicle or initial point *ex parte*), which, in the com

<sup>1</sup> The second chapter of Dr. Otto Herrmann's memoir on the Dichograptidæ the first chapter of which appeared in this MAGAZINE for September, 1885 Translated from the *Nyt Magazin for Naturvidenskaberne*, vol. xxix. pp. 160-176.